



**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant: Jeffrey Allen Neilsen et al.

Examiner: Leo B. Tentoni

Serial No.: 10/603,896

Group Art Unit: 1732

Filed: June 24, 2003

Docket No.: 100201650-1

Title: METHODS AND SYSTEMS FOR PRODUCING IMPROVED COLORING  
IN AN OBJECT PRODUCED THROUGH SOLID FREEFORM FABRICATION

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**DECLARATION UNDER 37 C.F.R. § 1.131**

Sir/Madam:

This Declaration is submitted to establish prior invention of the subject matter of the present patent application. The persons making this Declaration are the joint inventors, Jeffrey A. Nielsen, Steven T. Castle, and David C. Collins.

We, Jeffrey A. Nielsen, Steven T. Castle, and David C. Collins, declare as follows:

1. We are the named inventors of the subject matter described and claimed in the above-identified U.S. Patent Application Serial No. 10/603,896 filed June 24, 2003.

2. This Declaration under 37 C.F.R. § 1.131 is made in response to the Office Action mailed on Oct. 12, 2005, in which claims 1-3 and 9-19 were rejected under 35 U.S.C. §102(e), and claims 1-19 were rejected under 35 U.S.C. §103(a), based on Schmid et al., U.S. Patent Application Pub. No. 2004/0147630 assigned to Hewlett-Packard Company, entitled "Dissolving Complexes of Anionic Dye/Cationic Polymeric Fixer", having a filing date of January 28, 2003 and a publication date of July 29, 2004.

3. Prior to the January 28, 2003, filing date of Schmid et al., cited by the Examiner as referenced above, we conceived the above-identified and claimed invention. The claimed invention was constructively reduced to practice via the filing of U.S. Patent Application Serial No. 10/603,896. As factual evidence of our conception prior to the January 28, 2003 of Schmid et al., attached hereto and incorporated by reference herein, is Exhibit A.

**BEST AVAILABLE COPY**

**Declaration under 37 C.F.R. § 1.131**

Applicant: Jeffrey Allen Nielsen et al.

Serial No.: 10/603,896

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Title: METHODS AND SYSTEMS FOR PRODUCING IMPROVED COLORING  
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4. Exhibit A (8 pages) is a redacted confidential internal HP Invention Disclosure, entitled "Methods for improving color quality in a solid freeform fabrication tool" submitted by the joint inventors Jeffrey A. Nielsen, Steven T. Castle, and David C. Collins and received by the HP Legal Department prior to January 28, 2003. This invention disclosure was assigned HP Patent Disclosure No. (HPDN) 100201650 and describes subject matter of the present patent application.

5. HPDN 100201650 was forwarded to the law firm of Dicke, Billig, & Czaja, PLLC, requesting preparation of a U.S. Patent Application based upon the Invention Disclosure. Dicke, Billig, & Czaja, PLLC, is now located at Fifth Street Towers, 100 South Fifth Street, Suite 2250, Minneapolis, MN 55402 and specializes in patent, trademark, and copyright law.

6. Thereafter, Matthew B. McNutt, registration number 39,766, of Dicke, Billig, & Czaja, began preparation of a U.S. Patent Application based upon HPDN 100201650. Such application is the present invention of U.S. Patent Application Serial No. 10/603,896.

7. A draft of the present application, based on HPDN 100201650, was prepared by Matthew B. McNutt and forwarded to joint inventors Jeffrey A. Nielsen, Steven T. Castle, and David C. Collins via an e-mail transmission on April 17, 2003. As factual evidence of said e-mail transmission, attached hereto and incorporated by reference herein, is Exhibit B (1 page), which is a "hard copy" of a portion of the said e-mail transmission from Matthew B. McNutt to joint inventors Jeffrey A. Nielsen, Steven T. Castle, and David C. Collins dated April 17, 2003.

8. A revised draft application incorporating comments from joint inventors Jeffrey A. Nielsen, Steven T. Castle, and David C. Collins comments was prepared by Matthew B. McNutt and forwarded via an e-mail transmission on April 26, 2003, to Hewlett-Packard attorney Timothy F. Meyers. As factual evidence of said e-mail transmission, attached hereto and incorporated by reference herein, is Exhibit C (1 page), which is a "hard copy" of a portion of the said e-mail transmission to Tim Meyers dated April 26, 2003.

**Declaration under 37 C.F.R. § 1.131**

Applicant: Jeffrey Allen Nielsen et al.

Serial No.: 10/603,896

Filed: June 24, 2003

Docket No.: 100201650-1

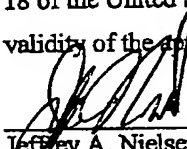
Title: **METHODS AND SYSTEMS FOR PRODUCING IMPROVED COLORING  
IN AN OBJECT PRODUCED THROUGH SOLID FREEFORM FABRICATION**

9. A final draft of the application and documents for filing with the U.S. Patent and Trademark Office were prepared by Matthew B. McNutt and forwarded via FedEx on May 14, 2003, to Hewlett-Packard attorney Timothy F. Meyers. As factual evidence of said e-mail transmission, attached hereto and incorporated by reference herein, is Exhibit D (2 pages), which is a "hard copy" of a portion of a cover letter to Tim Meyers dated May 14, 2003, and a copy of a FedEx airbill dated May 14, 2003.

10. On June 24, 2003, the present application, U.S. Patent Application Serial No. 10/603,896, was timely filed with the U.S. Patent and Trademark Office (U.S.P.T.O.).

11. It is therefore respectfully submitted that the present application claims an invention which was conceived prior to January 28, 2003 and diligently filed with the U.S.P.T.O. Thus, the Schmid et al. reference should be removed as a reference under 35 U.S.C. § 102(e) and also under 35 U.S.C. § 103(a).

12. We further declare that all statements made herein of our own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements are made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or patent issued thereon.

  
\_\_\_\_\_  
Jeffrey A. Nielsen


1-11-2006  
\_\_\_\_\_  
Date

  
\_\_\_\_\_  
Steven T. Castle

1-11-2006  
\_\_\_\_\_  
Date

  
\_\_\_\_\_  
David C. Collins

1-10-2006  
\_\_\_\_\_  
Date

	<b>Invention Disclosure</b> (WKRP Document Number 20020109.152112)		<b>Done Printing</b>
	PD No. <b>100201650</b>	Date Received by Legal <b>[REDACTED]</b>	Managing Attorney Curtis Rose

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## General Information

Write a descriptive title of the invention.

Methods for improving color quality in a solid freeform fabrication tool

Write a brief abstract of the invention.

There are many solid freeform fabrication (SFF) methods that can be used to make 3D objects. Some of these methods are capable of producing single-color or multi-color objects. The color reproduction accuracy of the objects coming from these tools is poor. This invention describes various methods that can be used to improve the color accuracy of objects from a SFF tool

Select projects associated with disclosed invention.

Zorro

Select product names or numbers associated with this invention.

Z406

## Description of Invention

List prior solutions and their disadvantages.

1) Existing systems create white by having a white media (powder) which is then infiltrated with a clear binder or dispensed material to create the solid part.

a) If the base media (powder) is not very white, then colors that are near white on the L\* (lightness) scale in color space will not be accurately reproduced

b) Unused base media from previous builds is often recycled to cut costs. This recycled base material often has broken or fine pieces of colorant in them from the previous builds. The larger pieces are visible as color speckle within the powder and the smaller pieces have an apparent greying effect to the white powder even if individual chunks are not visible.

2) Existing systems create black objects by using a composite of three colorants: cyan, magenta, and yellow.

a) Because of saturation limits in the media (powder), not enough colorant can be applied to the material to get colors that are near black on the L\* (lightness) scale in color space.

b) This composite black also suffers from metamerism (change in the apparent color based on the lighting in which the object is viewed)

3) Existing systems create metameric matches of colors using a combination of various amounts of three colorants: cyan, magenta, and yellow.

a) Some values in color space are not accessible using only a 3-primary system of colorant. While modifying the hue of these three base colorants can change the volume of color space (gamut) that is addressable, there are certain volumes in color space that will be impossible to address with a three color system.

4) Existing systems create metameric matches of colors using a combination of various amounts of three colorants: cyan, magenta, and yellow. Generally these colorants come from different members ejecting colored binder or material.

a) Existing systems assume that the size of the the material primitives (generally drop size) dispensed from these various members is equivalent in size. If there is variation in the size of the material primitives being ejected from each of the various colorant members, color inaccuracy will be the result (generally a hue error between desired and actual hue). For example, if one prints blue with a combination of magenta and cyan primitives, and the magenta primitives are too large relative to the cyan primitives, the blue will appear too 'pinkish'

5) Some existing systems create colored material by firing a colored binder into a white media (powder).

a) As the colorant soaks into the porous media, much of the colorant (dyes or pigments) will soak below the surface of the object. The deeper the colorant sinks into the object, the more faded the colors become as more air and media comes between the colorant and the observer.

**Explain the problems solved by the invention.**

- 1) Improved light colors near white on the L\* scale
- 2) Improved dark colors near black on the L\* scale
- 3) Improved color gamut (larger color space addressability)
- 4) Improved color accuracy
- 5) Improved representation of highly saturated colors.

**What are the advantages of this invention over what has been done before?**

1a) Allows for good light-colored parts even if media is not very white. Previous systems would not be able to do light L\* colors with a non-white media

1b) Allows for recycling of unused media (powder) without suffering a degradation in capability of doing light colors. Previous systems suffered from color speckle and media graying by reusing powder.

2a) Allows for good dark-colored parts without being as limited by the saturation limits of the media. Previous systems could not do good dark colors (blacks)

2a) Allows for consistent looking dark-colored parts in the presence of various lighting. Previous systems have suffered from metamerism in darker colors.

3a) Allows for addressing a larger overall color space than previous systems that only use a three-color system. Previous systems have had limitations in available color gamut.

4a) Allows better color accuracy in the presence of different sized material primitives. Previous systems have suffered from color inaccuracy (hue shift) when the volume or size of the material primitives from the various colorant members were different from each other.

5a) Allows better color saturation in porous media. Previous systems have suffered from poor color saturation when the colorant sinks in the media

**Describe the construction and operation of the invention.**

1) One embodiment of the invention uses a white pigment or dye colorant binder or dispensed material either in place of or in addition to a clear binder or dispensed material

a) This allows design flexibility in the media material in that the media does not have to be a bright white to allow light colors on the L\* scale.

b) The white pigment or dye could cover the graying of the recycled powder and cover the speckles from broken chunks.

2) Another embodiment of the invention uses a black pigmented colorant binder or dispensed material to create objects

a) This allows for darker blacks and for better color accuracy when making dark colors on the L\* scale.

3) Another embodiment of the invention uses colored binder or dispensed material other than just a cyan, a magenta, and a yellow to create objects.

a) Some examples of colored binders or dispensed materials that could be added to expand the available color gamut would be an orange, green, and/or violet binder or dispensed material, as is done in the graphic arts industry in some higher-end presses. This invention is not limited to these three examples

b) Another example would be to use a spot color binder or dispensed material such as silver or gold to be able to either get more realistic spot colors or to give metallic looking colors or colors with metallic flecks. This invention is not limited to these two examples

c) Another example would be to use in addition to fully loaded magenta and cyan to use a light dye/pigment load binder or dispensed material as a way to be able to better represent lighter colors without visual colorant grain. This invention is not limited to light dye/pigment loading with these two examples.

4) Another embodiment of the invention modifies the proportion or amount of colored binder or dispensed material that is dispensed from each member as a way to compensate for drop size or dispensed material primitive size variation from member to member.

a) An example of this embodiment would be to use data available about the performance of the member prior to its use in the SFF tool. Specifically, one could encode the drop weight from a measurement tool and record this weight onto an integral information device (chip or other means of data storage) on the member. The SFF tool could then read this data and modify the proportion of colored binder or dispensed material from each member to compensate for differences between the members. Similar systems have been employed in inkjet printing in the past, of which patent #5,812,156 is an example.

b) Another example would be to use a method similar to 4a but to characterize the typical performance of a binder or dispersed material member over life and make adjustments to the proportion of binder or dispensed material from each member to compensate for differences between members over life.

c) Another example of this embodiment would be to use a printed test pattern of colored tiles or other

shapes with various proportions of the primary colorants and have the user tell the SFF tool which of the tiles are the most neutral in hue. One could (but would not be required to) use some grayscale patterns printed with a true black colorant as a reference. The SFF tool could then take the proportions used in what the user has called the neutral pattern and modify the proportion of colored binder or dispensed material from each member during object creation to compensate for differences between the members.

d) Another example of this embodiment would be to have a color sensor within the SFF tool that looks at a printed test pattern of colored tiles or other shapes with various proportions of the primary colorants and measure the pattern that is most neutral in hue. The SFF tool could then take the proportions used in what the sensor has measured as the neutral pattern and modify the proportion of colored binder or dispensed material from each member during object creation to compensate for differences between the members.

e) Another example of this embodiment would be to have a drop weight sensor within the SFF tool that directly measures the size of the drops using an electrostatic drop detect system or various other systems. The SFF tool could then modify the proportion of colored binder or dispensed material from each member during object creation to compensate for differences between the members.

5) Another embodiment of the invention prevents a pigment or dye from sinking deeply into the porous media (and thus giving washed-out colors in the object) by causing a reaction that keeps the colorant portion of the binder or dispensed material near the surface of the object.

a) One example of this would be to create a reaction with a pigmented binder or dispensed material that would cause the pigment to 'crash' out of solution and remain near the surface. One method for creating this effect would be to create an ionic/cationic reaction between the media and the dispensed binder or material that would cause the pigment to crash out.

b) Alternatively a reaction between two of the dispensed binders or materials could cause this pigment crashing through ionic/cationic reaction. One example of this alternative would be to have the an ionic clear binder and a cationic colored binder be dispensed consecutively to create this reaction. Similar systems have been employed in inkjet printing in the past, of which patent #5,198,023 is an example.

c) Another example method for creating this effect would be to create a pH reaction. In this example, the pigmented binder or dispensed material could have a dispersant attached to the pigment that can be disturbed by a change in the pH of the binder or dispensed material. One could then have a basic binder or dispensed material that is fired into an acidic media. Or one could then have an acidic binder or dispensed material that is fired into a basic media. In either of these cases, once the binder or dispensed material hits the media, a change in pH will occur, crashing the pigment.

d) Another example method for creating this pH reaction would be to have different binders or dispensed materials at different pH levels. For example one could have an acidic clear binder and a basic colored binder dispensed consecutively to create this reaction. In this case, once the binder or dispensed material from the second member hits the binder or dispensed material from the first member, a change in pH will occur, crashing the pigment. Similar systems have been employed in inkjet printing in the past, of which patent #5,679,143 and #5,181,045 are examples.

e) In another example, one could add an alginate to the binder or dispensed material to prevent color bleed from one color to the next on the surface. While the above methods are concerned with colorant sinking into the surface, this method is concerned more with preventing colorant spreading on the surface. This would enhance the ability to make crisp edge of different colorants on the surface of the object. Similar systems have been employed in inkjet printing in the past, of which patent #5,133,803 is an example.

f) In another example, one could dispense a liquid fixer that had a function independent from the binding media or dispensed material. This material could be dispensed first onto the media and could have the function of fixing the colorant at the surface through one of the above mentioned chemical reactions.

<b>Invention History</b>
Was a description of the invention published, or are you planning to publish? If so, when and in what publications? No
When was this invention published?
Describe the details of the publication of this invention
Was a product including the invention announced, offered for sale, sold, or is such activity proposed? If so, when and where? No
When was this invention announced, offered for sale, or sold?
Describe the details of the announcement of this invention.
Was the invention disclosed to anyone outside of HP, or will such disclosure occur? No
Date this invention was or will be disclosed:
Describe the details of the disclosure of this invention. To whom will/has it been disclosed? Although this invention itself has not been disclosed, many of the concepts described here are inspired by 2D printing disclosures and are applied to Solid Freeform Fabrication
Will the invention be published, announced, or disclosed in the next 3 months? No
Was the invention described in a lab book or other record? Yes
Where, when, and how was this invention described? Recorded in Lab notebook 20844 (Jeff Nielsen Lab notebook #17) on pages 1 and 2. This was recorded on December 13, 2001 and witnessed by Terry Lambright and Shawn Hunter on December



20, 2001.

Was the invention built, modeled, or tested? If so, when?

No

When was this invention built?

Was the invention made under a government contract?  
If so, the agency and contract number:

No

Give the agency and contract number:

### Inventor Information

Pursuant to my (our) employment agreement, I (we) submit this disclosure:

	Employee Number	Location Code	Telnet	E-Mail	Site
Jeffrey A Nielsen	304157	6410-3032	715-5018	jeff_nielsen@ex.cv.hp.com	Corvallis, OR, US
Steven T Castle	255473	6410-3451	715-6914	steve_castle@ex.cv.hp.com	Corvallis, OR, US
David C Collins	304421	6410-5496	715-8343	david_collins@ex.cv.hp.com	Corvallis, OR, US

Enter the home address of each Inventor. This information is legally required to process your Invention Disclosure.

	Home Street Address	City	State or Province	Zip or Postal Code	Country
Jeffrey A Nielsen	4553 N.W. Elmwood Drive	Corvallis	OR	97330	United States [US]
Steven T Castle	811 Pioneer St.	Philomath	OR	97370	United States [US]
David C Collins	581 Canberra	Philomath	OR	97370	United States [US]

Select the country of citizenship for each Inventor.

	Citizenship
Jeffrey A Nielsen	United States [US]
Steven T Castle	United States [US]
David C Collins	United States [US]

Type the HP Mail Stop for each Inventor.

Jeffrey A Nielsen  
Steven T Castle  
David C Collins

Mail Stop  
1032B  
611A  
1032B

Please list the names, home addresses, telephone numbers, email addresses, and countries of citizenship of inventors who are not affiliated with HP.

### Witness Information

This invention has been explained to and understood by the following witnesses (you must name at least two witnesses).

Shawn D Hunter  
Terry M Lambright

At what date was this invention first explained to and understood by each witness?

Shawn D Hunter  
Terry M Lambright

Date Understood  
December 20, 2001  
December 20, 2001

### Attachments

Do you have electronic document files to upload? Please convert your documents into MS Word, PowerPoint, Adobe Acrobat, or plain text format.

Do you have paper documents to include with your Invention Disclosure that you would like to send by FAX?

### Additional Information

Select WKR P categories where this invention disclosure should be indexed.

General: Print Quality, Ink and Media: Colorant and Interfaces - Printer to Marking Engine: Drop Detector

Select keywords to index this invention disclosure.

dot size, dye-based ink, hexachrome and pigment

Was this Invention Disclosure prepared as a result of an Innovation Workshop? If you are not sure, select No.

No
<b>Does this disclosure relate to a previously submitted disclosure? If so, please provide the PD number of the related disclosure and explain.</b>
No
<b>What is the PD Number of the disclosure this one is related to?</b>
<b>Explain how this disclosure is related to a previous one</b>

<b>Administrative Record</b>
<b>Select the name of the Patent Clerk(s) working on this Invention Disclosure:</b> Ann Lygas
<b>Select the name of the Legal Admin(s) working on this Invention Disclosure:</b> Ann Lygas
<b>Record the PD number assigned by Merlin and modify the date this disclosure was received, if necessary.</b> 100201650
<b>Enter the legal received date:</b> January 22, 2002
<b>Select the name of the Patent Coordinator(s) who will work on this Invention Disclosure:</b> Jeffrey M Valley
<b>Select the name of the Managing Attorney(s) assigned to this Invention Disclosure:</b> Curtis Rose
<b>Select a Legal Entity and Site where this Invention Disclosure will be handled and reviewed:</b> IJS
<b>Please select a Legal Site:</b> Corvallis

**EXHIBIT B**

**From:** Matthew McNutt  
**To:** d\_collins@hp.com; jeff\_nielsen@hp.com; steve.castle@hp.com  
**Date:** 4/17/03 7:24PM  
**Subject:** Draft Patent Application (HP 100201650; DBC H301.269.101),

Gentlemen:

Attached for your review and comment is a draft patent application for your HP invention disclosure 100201650, entitled "Methods for Improving Color Quality in a Solid Freeform Fabrication Tool".

~~\_\_\_\_\_~~  
~~\_\_\_\_\_~~ You previously provided me comments on the claims, and those comments have been incorporated into the claims and the detailed description.

I look forward to receiving your comments.

Regards,

Matt

\*\*\*\*\*

Matthew B. McNutt  
Dicke, Billig & Czaja, PLLC  
Suite 147  
8834 Capital of Texas Highway North  
Austin, Texas 78759

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**CC:** Chrissy Johnson

**EXHIBIT C**

**From:** Matthew McNutt  
**To:** tim.myers@hp.com  
**Date:** Sat, Apr 26, 2003 12:01 PM  
**Subject:** HP 100201650 Draft Patent Application (DBC H301.269.101)

Mr. Myers:

Attached for your review and comment is a completed patent application based on HP's Invention Disclosure 100201650.

The application has been reviewed and approved by the inventors (Jeff Nielsen, David Castle and Steve Collins).

Upon your approval of the application, a set of claims and an abstract for the EP filings will be prepared.

I look forward to receiving your comments.

Regards,

Matt

\*\*\*\*\*  
Matthew B. McNutt  
Dicke, Billig & Czaja, PLLC  
Suite 147  
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# DICKE, BILLIG & CZAJA, PLLC

EXHIBIT D

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ATTORNEYS

Suite 147 • 8834 North Capital of Texas Highway • Austin, Texas 78759  
Telephone: (512) 231-0530 Facsimile: (512) 231-0540

Matthew B. McNutt  
Direct: 512-321-0531

May 14, 2003

Timothy F. Myers  
HEWLETT-PACKARD COMPANY  
Legal Department, M/S 422B  
1000 NE Circle Boulevard  
Corvallis, OR 97330-4239

RE: U.S. Patent Application for:  
**METHODS AND SYSTEMS FOR PRODUCING IMPROVED COLORING  
IN AN OBJECT PRODUCED THROUGH SOLID FREEFORM  
FABRICATION**  
HP File No: 100201650-1  
DBC File No.: H301.269.101

Dear Tim:

Please find enclosed the following documents suitable for filing with the U.S. Patent and Trademark Office for the above-referenced patent application:

- Hard copy of Patent Application and Formal Drawings;
- Electronic copy of Patent Application and Formal Drawings on CD-ROM;
- Hard copy of EP Claims and Abstract;
- Electronic copy of EP Claims and Abstract on CD-ROM;
- Form PTO-1449; and
- Duplicate copies of Fifteen (15) cited references.

If you have any questions regarding this matter, please contact me at (512) 231-0531.

Regards,

DICKE, BILLIG & CZAJA, PLLC

Matthew B. McNutt

MBM:dmd

Enclosures

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Sender's Name Matthew McNutt Phone (512) 231-0531

Company Dicke, Billig & Czaja, PLLC

Address 8834 Capital of Texas Hwy ste 147

City Austin State TX ZIP 78759

2 Your Internal Billing Reference (H301.269.1011MBM:dmd)

3 To  
Recipient's Name Timothy F. Myers Phone ( )

Company Hewlett Packard, Legal Department

Address M/S 422B, 1000 NE Circle Boulevard

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City Corvallis State OR ZIP 97330-4239

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Next business morning Next business afternoon

☐ FedEx 2Day ☐ FedEx Express Saver  
Second business day Next business day

4b Express Freight Service  
Delivery commitment may be later in some areas.  
☐ FedEx 1Day Freight\* ☐ FedEx 2Day Freight  
Next business day Next business day

5 Packaging  
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Includes FedEx Small Pak, FedEx Large Pak, and FedEx Sure Pak

6 Special Handling  
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Available only for FedEx Priority Available only for FedEx Priority  
Overnight and FedEx 2Day Overnight to select ZIP codes

7 Payment Bill to:  
☒ Sender ☐ Recipient ☐ Third Party ☐ Credit Card ☐ Cash/Check

Total Packages Total Weight Total Declared Value\*

8 Release Signature Sign to authorize delivery without obtaining signature.

404

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